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## A GREAT NATURAL PHILOSOPHER.

*Life and Scientific Work of Peter Guthrie Tait.* By Cargill Gilston Knott. Pp. x+379. (Cambridge: University Press, 1911.) Price 10s. 6d. net.

TWO large quarto volumes of Prof. Tait's collected papers were published some time ago by the Cambridge University Press, and these have now been supplemented by an exceedingly interesting account of Tait's life and work, from the pen of his pupil and friend, Dr. C. G. Knott. Every Edinburgh student must recognise the fidelity of the picture which Dr. Knott has drawn, and feel that his book is in all respects a worthy memorial of the great Edinburgh professor. The book will appeal very directly to many of the readers of NATURE, who remember the searching and trenchant reviews of books on physical mathematics, and the articles on such subjects as the physics of golf, and on questions connected with physical mathematics, which appeared in these columns from time to time, and were signed with the initials "P. G. T." Many of these less formal papers were of much scientific interest, which was not lessened by the eminently human personality of the writer, which appeared in every sentence, and the humour, a little grim at times, with which he illustrated or drove home his conclusions.

In a review of Tait's "Thermodynamics" in NATURE (January 31 and February 7, 1878, vol. xvii.) Clerk Maxwell said, "Science has enough to do to restrain the strong human nature of the author, who is at no pains to conceal his own idiosyncrasies, or to smooth down the obtrusive antinomies of a vigorous mind into the featureless consistency of a conventional philosopher." These words are a true description of Tait, the outspoken and uncompromising controversialist, the critic unsparing of error, but not without regard for the feelings of the advocates of views which he combated or denounced, the philosopher who said hard things regarding professed metaphysicians, but who thought of the foundations of dynamics and did not disdain to adduce metaphysical considerations for the justification of a fundamental principle of quaternions. Such men are rare at the present time. Everybody is superficially and laboriously polite; the old broadsword play of word and phrase is too often replaced by suggestion and innuendo. But a good knockdown blow or cut is better than a sting that empoisons the blood and festers.

Tait was a native of Dalkeith, near Edinburgh, and studied his rudiments in the grammar school of that town. At the age of ten, on the death of his father, he was brought with the family to the city in which his life-work was to be done, and became a pupil of the Edinburgh Academy, a day school which from its foundation in 1824 has always been famous for the soundness of its classical and mathematical instruction. There he had as schoolfellows Clerk Maxwell, Lewis Campbell, Fleeming Jenkin, and several others who achieved eminence or fame in after life. Maxwell was his senior by a year. It is foolish to attach very great importance to school examinations—some minds begin to mature sooner than others—but it is interesting to note that Tait, Campbell, and Maxwell seem to have been nearly equally distinguished in mathematics. All were soundly drilled in classics; the rector of the academy was an eminent classical scholar—the Ven. John Williams (curiously enough at the same time Archdeacon of Cardigan), who was chosen first rector in 1824, mainly at the instance of Sir Walter Scott. Tait had an excellent verbal memory, and used in after life to repeat much Greek and Latin poetry learned in the forms of the academy.

It is rather remarkable that at the University of Edinburgh neither Maxwell nor Tait excelled the best of their fellow-students in natural philosophy. Perhaps in music alone does early precocity precede the highest excellence in maturity; but then musical genius is much less dependent on the ripening of the logical powers. For original work in mathematics and physics a natural gift or instinct is, of course, essential.

Tait's career at Cambridge, and his initiation in the following years into experimental work in the laboratory of Dr. Andrews at Belfast, were incidents in the scheme of things which led to his return to Edinburgh in 1860 as the successor of Forbes. Tait entered at Peterhouse in 1848, Maxwell in 1850, but afterwards migrated to Trinity, and both, like Thomson (afterwards Lord Kelvin) before them, had William Hopkins as their private tutor. Each had his own strong personality, but the influence of that great teacher seems to have been of the best possible kind for the minds of all. Tait was Senior Wrangler and First Smith's Prizeman in 1852, and his first act when the Tripos result was declared was to telegraph home and ask that the news should be told to Gloag, his old mathematical master at the academy.

While professor of pure mathematics in Queen's College, Belfast, and working in the laboratory of Dr. Andrews, he was introduced by Andrews to Rowan Hamilton, at that time in the full tide of his quaternion work, and busy with the preparation of the "Elements" for publication. Then began an interchange of letters on quaternions, of which Dr. Knott, *con amore* as himself an ardent and accomplished quaternionist, has given a most interesting account. Apparently Tait's first letters, which were chiefly on difficulties raised by his perusal of the "Lectures on Quaternions," attracted Hamilton's attention to the writer as one likely to cultivate the new calculus and extend it to fields of physical research. Hamilton's own applications were mainly geometrical; Tait saw in quaternions a powerful instrument for the dynamical study of various branches of physics, which, in fact, placed at once in a new light all that analysis, applicable to so many different problems, in which Green's analytical theorem plays a prominent part. The result was his paper on Green's theorem, and, later, many of those physical investigations which form the latter part of his "Treatise on Quaternions."

Hamilton was a willing and voluminous correspondent, and his letters (the first was forty-five pages long, divided into thirty-two paragraphs), here printed, so far as they are quoted, with all the italics, small capitals, &c., which he used, even in his books, to mark different degrees of emphasis, abound in acute and suggestive remarks, which were no doubt due to the inspiration of the moment. The humour which he displays here and there, as in his "mortal leap from Chaucer to Moigno," and his description of the Abbé, is of a truly Irish flavour, and has the merit of unexpectedness.

The absence of quaternions from Thomson and Tait's "Natural Philosophy" has been the subject of some remark. It is now well known that the senior author could not be convinced that the quaternion calculus, or indeed any form of vector analysis, was of advantage in physical work. To this conservative view he adhered to the end of his life, and in a private letter of his later years, written, as he described it, politely and mildly as to a stranger, he states his adverse opinion with remarkable vigour. And there is the letter to Chrystal, quoted by Dr. Knott on p. 185, on the thirty-eight year war over quaternions.

It is somewhat remarkable that vectors should have led to so much correspondence of an animated sort. The respective merits of quaternions and the systems of Grassmann and others seem not merely to have kindled the intellects, but to have stirred the emotions of the various advocates to a surprising extent. The playful paraphrase by a physicist of the famous saying of Tertullian into "Behold, how these vector-analysts love one another!" suggests with a touch of irony that after all the differences may not be so fundamental as they appear, that perhaps each sees the truth, and may safely be left to fight its battle in his own way. Let each go on using the armour and weapons he has proved; no man can tell to whom the victory may be; perhaps after all to someone whose equipment seems lamentably inadequate. But nobody can help admiring the steadfast fidelity of Tait to the notation of the master, and his chivalrous defence of quaternions against all comers. He had a right to speak with authority: no man with the exception of Hamilton himself did more for quaternions or with them. And if the linear vector function ever yields its whole secret to the student of vector analysis, it will be because Tait has made the disclosure possible. Often light suddenly comes to a man who has turned a subject over in his mind for weeks or months or years. It is surely also possible that one explorer may enter into the labours of another, and quickly behold the promised land which the instinct and faith of the first pioneers told them lay beyond the mountains.

Cambridge had no more systematic student than Tait, and no university had a more faithful and duty-doing professor. The work to hand, the daily task, the common round of teaching, it was his joy to perform. In the opinion of some it is waste to keep such a man lecturing to elementary students; but Tait inspired his students, and that was surely a very great thing. As a lecturer on experimental physics he was well-nigh unapproachable; and he was well aided by his mechanical assistants, who understood his methods and knew that he could be depended on to take everything in the carefully thought-out and pre-arranged order. Without such order and close adherence to it, no man, however eminent, however great his genius even, can teach a university class effectively.

In his introductory and other occasional addresses, Tait often dealt with more or less controversial subjects. The tract which he wrote on "Thermodynamics" contains a sketch of the theory of energy, in which questions of priority of complete logical proof, for example, Joule's establishment of the equivalence of heat and work, are discussed with great force and cogency of argument, albeit with a dash of patriotism. Such things he also discussed in his popular lectures and lighter papers. His book on "Recent Advances in Physical Science," was a course of such lectures, taken down by a shorthand writer, and carefully revised. Its title is out of date now, but as a clear statement of the true foundations of the science of heat, and of the work done by Joule, Kelvin, Balfour Stewart, and others in that field, it cannot be excelled.

In thermodynamics he insisted always on the importance of Kelvin's idea of absolute temperature. Kelvin was undoubtedly behind Clausius in accepting the consequences of the equivalence of heat and work; but when his first scruples had been overcome, and Carnot's function had disappeared in the idea of absolute temperature, the scheme of relations of heat and work stood forth in a logical clearness, which no other mode of treatment has ever approached. The imperfectly specified thing called a "perfect gas," by means of which temperature is defined in many continental treatises, he cordially disliked, and he lost no opportunity of denouncing the treatment founded upon it. In the cause of accuracy Tait was zealous almost to slaying. No one who heard his lecture on "Force," to the British Association at Glasgow in 1876, will ever forget his dramatic denunciation of slipshod popular science and its professors.

Tait's association with Kelvin in the composition of the "Natural Philosophy" has been referred to. Not the least interesting chapter in Dr. Knott's book is the account of this collaboration. The two men had much in common, they were both pupils of Hopkins, their great mathematical power and sure physical instinct well fitted them to work together, but in other respects the combination was not so successful. Tait was orderly and methodical—that can be seen in his neat penmanship and clear and precise composition, which was fit, with scarcely an erasure or substituted word, to be sent to the printer. On the other hand, the perusal of matter in clear print on a proof-sheet, showed Kelvin so many opportunities of extension and amendment, that he immediately overflowed in new sections on the margins, to the dismay of the printers, and the augmentation of the bill of costs. Then Kelvin had so many irons in the fire; his thoughts were being carried away continually from the "Natural Philosophy," and that, of course, stood still, for there come times when one partner in such an enterprise cannot advance without the other. No wonder the book stopped at the end of the first volume.

For many years Tait was the general secretary of the Royal Society of Edinburgh, and of the 365 papers, the titles of which are enumerated in Dr. Knott's bibliography, by far the greater number were communications to the society's Proceedings or Transactions. Unlike most secretaries of learned societies, he was himself the most prolific contributor.

He never joined the Royal Society of London, though he was a royal medallist in 1886, and was often asked to allow his name to be submitted. Indeed, his heart was in Edinburgh and his work there. For the last twenty-five years of his life he never crossed the Tweed; the only occasions on which he left the city were his visits to St. Andrews, ten days in spring and six weeks in autumn, with one exception, when he went to Glasgow to deliver a lecture on thunderstorms.

Though not himself a great golfer, he was the recognised authority on the physics of the game. His explanations of the "carry" of a golf ball, of the action of toeing, heeling and slicing, all examples of his theory of the effect of spin, stood the severe test of his own experiments, and are beyond cavil. His papers on this subject—in NATURE and elsewhere—would form an interesting book on the dynamics of a spherical projectile in air, if they were collected.

Failing health, and the death of his son, Lieut. F. G. Tait, the great amateur golfer, at Koodoosberg in 1900, brought the toil of his strenuous life to a close. But at the last, only two days before his death, he was busy with his beloved quaternions, and wrote a sheet of notes of investigations on the linear vector function.

This notice is already too long, and yet nothing has been said of Tait's work on thermoelectricity, on mirage, or of "The Unseen Universe," and the "Paradoxical Philosophy." The two last-mentioned works, written in conjunction with Balfour Stewart, are interesting as an attempt to apply the principle of continuity to infer, and to some extent explain, the existence of an unseen system of things to which in some sort we stand in physical relation. Incidentally they show the strong yet unobtrusive religious faith of their authors.

A. G.

## AUSTRALIAN PLANTS.

*Australian Plants Suitable for Gardens, Parks, Timber Reserves, &c.* By W. R. Guilfoyle. Pp. 478. (Melbourne and London: Whitcombe and Tombs, Ltd., n.d.) Price 15*s*. net.

THIS work, prepared, as we learn, at the request of a special committee, embodies the practical experience of its author during the past thirty-six years. Except for some five-and-twenty pages of preliminary matter, the book is not one that admits of being read. But this fact in no way detracts from its merits as a work of reference, or lessens the debt to Mr. Guilfoyle of Australians who care either for gardening or for Australian plants. The feeling, its author explains, which has inspired its publication, is a desire to arouse increased enthusiasm in regard to the native species. The introduction should at any rate have the effect of directing the attention of his compatriots to the fact that Australia is richly endowed with what is wonderful and beautiful in the vegetable kingdom. If it does have this effect, it will have well served its purpose, since all that can be needed to evoke the enthusiasm which is desired is some intelligent attention to the plants themselves.

Granted the existence of such enthusiasm the work before us must prove invaluable in guiding and controlling it. That some control will be needed an examination of Mr. Guilfoyle's lists abundantly shows. The value of the lists for this purpose is enhanced by the self-restraint which has enabled the author to confine to a couple of lines references to individual plants which those who are not themselves Australians would gladly have seen expanded to as many pages.

It is scarcely strange that the inhabitants of an autonomous State like the Australian Commonwealth should be less enthusiastic over their native plants than the inhabitants of Britain. The wattles and gums, the myrtles and honeysuckle trees, the Boronias, Brachycomes, and Epacrids of Australia do not yet arouse feelings and memories so keen as those aroused by the oak and thorn and gorse, the primrose or the daisy or the heather of Britain. There is, however, more than the mere absence of literary allusion or historical association to account for the fact. In Australia the number of forms capable of awakening interest or provoking admiration is so immeasurably greater than in Britain that the observer's attention is distracted. Even where, in spite of greater or less botanical differences, the plant-forms of the two countries are sufficiently alike to be comparable from an æsthetic point of view, as, for example, in the case of the Epacrids or Australian heaths and our familiar ling, the manifest superiority of the Australian plants scarcely suffices to produce the expected effect. Perhaps the fact that the enthusiasm of the Australian has to be extended to a dozen different forms, while we can concentrate ours on one or two, may be some explanation. Should Mr. Guilfoyle's own enthusiasm enable his fellow-countrymen to overcome this difficulty, he may truly be said to have deserved well of the Commonwealth.

The attempt made in a special list to bring some order out of the chaos which prevails in respect of the common names applied to Australian Eucalypts in different parts of the country, deserves especial attention. How great the prevailing confusion is will be readily appreciated if the Eucalyptus names recorded in Mr. Gerth van Wijks's "Dictionary" be examined. Mr. Guilfoyle's courage in endeavouring to deal with this troublesome question compels our admiration. It is perhaps too much to expect that everyone all over Australia will be willing to abandon the use of names to which they personally have become accustomed, and to be guided by what, after all, must at best be a somewhat eclectic set of substitutes. But if in this particular matter it can scarcely be hoped that Mr. Guilfoyle's action will receive the universal approval